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Influence of male age on sperm quality in the rainbow trout

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The influence of spawners' age on the progeny in fish has been described in the literature by a number of authors (1-4). In these papers, we read that fish maturing for the first time and old spawners produce the least viable offspring. At the same time, the influence of male age on the quality of the genital products has not been studied sufficiently. Scheuring has noted a relationship between the time of spermatozoa motility and the age of the males (5). The spermatozoa remained active for the longest time in middle-aged fish. K.K. Tereshchenko (6) has established a correlation between the concentration of spermatozoa and the age and weight of the spawners in vobla (*Rutilus rutilus*). Ye.K. Suvorov (7) notes that a correlation exists between male age and the concentration of spermatozoa in the Volga shad; a liquid "bluish" sperm is produced by older males. However, in their investigations involving carp, taran (*Rutilus rutilus heckeli*), Issyk-Kul trout and white amur (*Ctenopharyngodon idella*), researchers were unable to establish a relationship between male age and the period of spermatozoa motility, and in some cases between age and the concentration of spermatozoa (8-11). At the same time, it was shown that the volume of a one-time batch of sperm increases with the body size of the males, and the number of unviable

spermatozoa increases in old males. In his study of *Rutilus rutilus heckeli*, V.N. Zhukinsky (8) noted a positive correlation between the age of the males and the volume of their ejaculate, the coefficient of correlation being equal to +0.68.

In an earlier study, we noted a relationship between sperm quality and male age in the rainbow trout (12), as well as a correlation between the weight of the spawners and the volume of a one-time batch of sperm (r= +0.35), and between the weight and concentration of spermatozoa (r= -0.22) for male rainbow trout of the same age group (13).

The purpose of this study was to determine the influence of male age on sperm quality in rainbow trout raised in ponds.

Our material consisted of 2—6-year-old males from the Gostilitsky brood stock of rainbow trout. A total of 749 spawners were involved in the study. We examined the quality of the sperm (duration of spermatozoa motility and spermatozoa concentration) and the volume of a one-time batch of sperm. We also determined the fertilizing capacity of rainbow trout males of different age.

The duration of spermatozoa motility was determined by the standard method (14). The concentration of spermatozoa was determined on a FEK-M photoelectrocalorimeter using red light filters. The volume of a one-time batch of sperm was measured with a calibrated cylinder with up to 0.1 cm^3 accuracy. Fertilizing capacity was judged on the basis of the percentage of eggs fertilized. The roe of ten females was mixed, and then divided into several portions. Each portion was fertilized with sperm from males of different age. From each batch of eggs, we examined 100 blastodiscs in pressed preparations.

In our analysis of sperm quality, we found that it depended on the age of the spawners (table 1).

Our data show that the quality of the sperm depends on the age of the males. The period of spermatozoa motility increases somewhat with the age of the males; it reaches its maximum value in fourth-year spawners, and then diminishes somewhat. Our data are consistent with Scheuring's conclusion that middle-aged males of rainbow trout produce the most active sperm. Perhaps the decrease in the period of spermatozoa motility in older fish is due to changes in the biochemical composition of their sperm (15).

The concentration of spermatozoa in rainbow trout males decreases abruptly with age (see table 1). In sixth-year males, the concentration of spermatozoa is half of that in second-year males maturing for the first time. The same relationship between spermatozoa concentration and male age was established by V.N.

Zhukinsky (8) for *Rutilus rutilus heckeli*. G.V. Popova (11) did not observe this correlation in the white amur; according to her data, the concentration of spermatozoa increases with the age of the spawners in white amur males. In their study on carp, F.G. Martyshev and coauthors (9) were unable to establish any differences in the concentration of spermatozoa in males of different age. Apparently, these mechanisms vary in males of different species, i.e. they are determined by species characteristics.

Table 1. Dependence of sperm quality on male age in rainbow trout

Age of males, yr	No. of males	Size of males		Period of spermatozoa motility s	Spermatozoa concentration, 10^6 per mm^3	Volume of one-time batch of sperm, cm^3	Total no. of spermatozoa, 10^9
		Average weight, g	Fork length, cm				
2	202	395	30.2	31.3	9.5	3.1	29.5
3	270	890	39.4	34.8	6.4	5.0	32.0
4	185	1243	45.9	37.1	6.0	6.8	40.8
5	68	1514	50.1	33.3	5.4	9.6	51.8
6	15	1943	55.9	31.9	4.7	11.6	54.5

In rainbow trout males, the volume of a one-time batch of sperm increases significantly with age (see table 1). The batch of sperm obtained from sixth-year males is nearly twice as large as the one obtained from fourth-year males, and four times larger than the batch obtained from second-year males maturing for the first time. The mass of the generative tissue of the testes increases with the age of the males and, consequently, the volume of a batch of sperm produced by them also increases, i.e. the fecundity of the males increases.

A study of the fertilizing capacity of rainbow trout males has shown that it increases somewhat up to the fourth year, and then decreases slightly (table 2).

Male fish have the lowest fertilizing capacity in their second year, and the highest in the fourth year.

The variability in fertilizing capacity is not extensive in the males of the rainbow trout. The coefficient of variation reaches its maximum value (8-9%) in second-year males, and decreases (v=5-6%) in fourth-year males because of a sudden decrease in the range of individual variations.

By subjecting our data to single-factor analysis of standard deviation, we calculated the influence of male age on the quality of the sperm and its fertilizing capacity (table 3).

Table 2. Fertilizing capacity of rainbow trout males

Age of males, yr	No. of males in experiment	% of fertilized eggs		
		1st replication	2nd replication	Average
2	20	74	78	76
3	20	89	87	88
4	20	92	94	93
5	20	88	90	89
6	15	81	79	80

Table 3. Influence of male age on sperm quality and fertilizing capacity in males of the rainbow trout

Indices	η_x^2	$\pm m_{\eta x 2}$	ηz^2	F
Volume of one-time batch of sperm	0.21	0.007	0.79	30.0
Period of spermatozoa motility	0.29	0.007	0.71	41.3
Concentration of spermatozoa	0.15	0.008	0.85	18.7
Fertilizing capacity of males	0.46	0.015	0.54	30.4

Apparently, the age of the males influences the volume of a one-time batch of sperm largely through the body size of the males. As the fish age, their size increases, and so does the size of their gonads. The correlation between the size of the males and the volume of the ejaculate, established for other species of fish (8, 16), was noted by us for the rainbow trout (13). Due to age-related changes in the biochemical composition of the sperm, the age of the males directly influences the period of spermatozoa motility, as well as the concentration and fertilizing capacity of the spermatozoa (15).

When breeding trout, we must take into account the strong correlation between male age and sperm quality. When forming a brood stock of trout, we should select only the best middle-aged males for further use, culling the older spawners to improve the stock.

The results of our work have brought us to the following conclusions:

1. Sperm quality in males of the rainbow trout depends on the age of the spawners. The duration of spermatozoa motility is at its maximum in middle-aged fish. The concentration of spermatozoa diminishes with the age of the males.

2. The volume of a one-time batch of sperm increases considerably with age.

3. Fourth-year males of the rainbow trout have the highest fertilizing capacity.

4. Male age has a 21% influence on the volume of a one-time batch of sperm, 15% influence on the concentration of spermatozoa, and 29% influence on the period of spermatozoa motility. The influence of male age on fertilizing capacity is equal to 46%.

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